Some AUSTRALIAN CARYOPHYLLAEID CESTODES

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Fig. 1–10.

The present paper records the occurrence of four species of Caryophyllaeid cestodes from the intestine of the widely distributed Australian freshwater Siluroid catfish, *Tandanus tandanus* Mitchell. One of these, *Balanotaenia bancrofti*, had been previously described from material collected in eastern Queensland. The other three are considered to be new; two of them are assigned to a new genus of Lytocestinae, *Notolytocestus*, as *N. major* and *N. minor*; while the other is placed under *Biacetabulum* (*B. tandani*) and is the only known Australian representative of the Caryophyllaeinae.

Types of the new species have been deposited in the South Australian Museum, Adelaide. We desire to thank G. G. Jaensch and L. Ellis of Tailem Bend, South Australia, and our colleague, Miss L. M. Angel, for supplying most of the catfish; and to acknowledge our indebtedness to the Commonwealth Research Grant to the University of Adelaide.

Balanotaenia bancrofti Johnston.

Fig. 9–10.

This small species was the first described by Johnston (1924) from material collected from the upper Burnett River, Queensland, by Dr. J. M. Mackerras and her father, the late Dr. T. L. Bancroft.

We have examined catfish caught at Tailem Bend by Mr. G. G. Jaensch and at Murray Bridge by Mr. L. Ellis in 1939 and 1942 and Miss L. M. Angel in 1947 and 1948. Our findings were as follows, the locality being Tailem Bend unless otherwise stated: November 1937, one, infected; December 1937, two fish, both infected; May 1938, positive; January and February 1939, positive; October 1939, one positive and one negative; October and November 1939, from Murray Bridge, the former positive; February 1940, a very young fish, negative; March 1941, a very young fish, 1·25 inches long, negative; May 1941, four fish, 1·25–1·5 inches long, all negative; November 1941, many cestodes, some very large and some very small; February 1942, Murray Bridge, two fish, both infected,

some of the parasites being very young; March 1942, one positive and one negative; April 1945, very heavily infected; May 1945, heavily infected; April 1947, Murray Bridge, negative; December 1947, Murray Bridge, two fish, both infected; January 1948, Murray Bridge, two fish, both negative; May 1948, Murray Bridge, positive; February 1949, Murray Bridge, a fish under two inches long, negative. Thus of 32 fish examined, 18 contained *B. bancrofti*. All fish three inches or less in length, were free from infection. Since such small fish were all captured in a swamp, it is likely that the intermediate host lives in the deeper water of the river where larger catfish occur. If we exclude the seven very young fish, there were 18 of 25 adult fish found to be infected, i.e. 72 per cent

Very young stages of the parasite, along with adults, were found in November, December, February, April and May. The heaviest infection was observed in April, 1945 when 156 *Balanotaenia* (including many young stages) were taken from one fish. The usual number was 12–20. There was no opportunity to examine catfish during the winter months (July–September). Infected fish were found during each of the remaining months.

Dr. J. Mackerras informed us that *B. bancrofti* occurs in *Tandanus tandanus* in the vicinity of Cairns, North Queensland; and one of us has examined material from the Murray in the vicinity of Mildura. The parasite is thus present in Queensland, New South Wales, Victoria and South Australia, its host fish occurring in the Murray-Darling river system and in the rivers of eastern Australia.

A detailed account of the anatomy of *B. bancrofti* was published in 1924. The smallest specimen which we obtained from the Murray region was about one millimetre in length, a size agreeing with the smallest of the worms from the Burnett River.

In one catfish taken by Miss Angel near Murray Bridge in December, 1917, there were present, beside numerous *Balanotaenia*, a few *Notolytocestus major*, together with one *N. minor* and one *Biacetabulum tandani*; while in another taken on the same occasion, there were two *N. major* as well as many *Balanotaenia*.

NOTOLYTOCESTUS MAJOR gen. et. sp. nov.

Fig. 1–5.

This relatively wide Caryophyllaeid was encountered only twice; on both occasions in *Tandanus tandanus* caught at Murray Bridge in December, 1947, *Balanotaenia* also being present. In one of these fish there was also a single specimen of *Notolytocestus minor* and of *Biacetabulum tandani*.

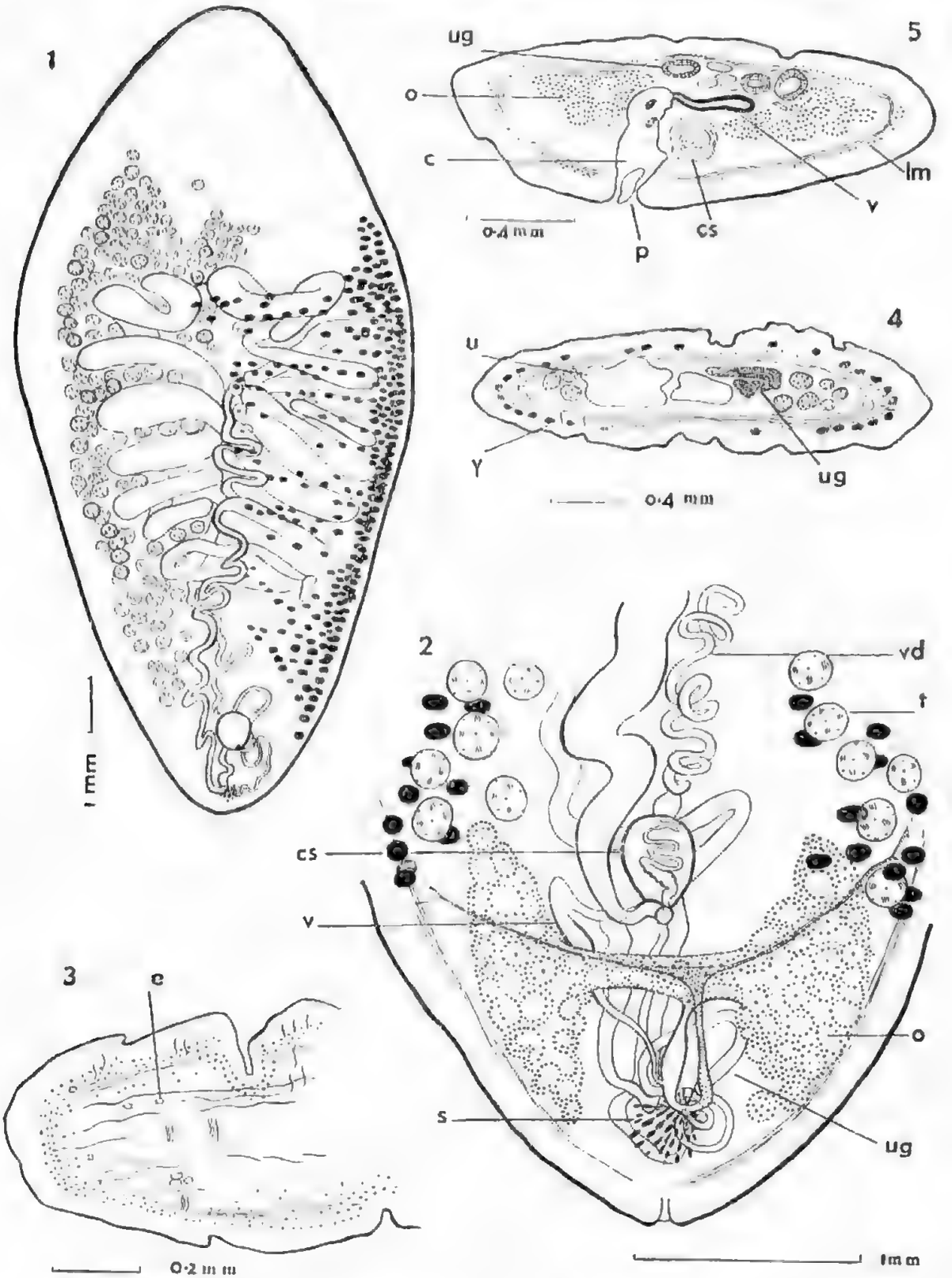

Fig. 1–5. *Notolytocestus major*. 1, ventral view, showing the path of the uterus, and on one side the distribution of the testes, on the other, the vitellaria; 2, reproductive system; 3, transverse section near anterior end showing musculature; 4, transverse section through uterine area showing both glandular and non-glandular uterus and arrangement of vitellaria; 5, transverse section through the genital pore and utero-vaginal canal showing entrance of vagina into the latter.

e utero-vaginal canal; cs cirrus sac; o excretory canal; lm longitudinal musculature; o ovary; s shell gland; p genital pore; t testes; u uterus; ug glandular uterus; v vagina; vd vas deferens; y vitellaria.

The measurements of adult *N. major* ranged from 17 mm. in length by 8 mm. in maximum breadth to 13 mm. by 5 mm. A specimen devoid of eggs measured 11·5 mm. by 5·5 mm. The region of greatest width was at about the end of the anterior third of the body length. The worms are flattened dorsoventrally, with the anterior end generally more bluntly rounded and sometimes provided with a small projection. Apart from the latter there is no differentiation of a scolex. The unspecialized nature of the anterior region of the worm is apparent in transverse sections. Just behind this there can be seen in sections small longitudinal furrows or grooves produced by contraction of the underlying muscles.

There is a very narrow band of small subcuticular longitudinal muscles, and lying more deeply in the cortex is a relatively wide band of numerous similar muscles, this zone being widest in the anterior region of the worm. Inwardly from this layer of longitudinal muscles are transverse muscle fibres forming a dorsal and a ventral series and at right angles to these are groups of dorsoventral muscle fibres extending into the cortex above and below (fig. 3).

Many excretory canals can be seen in the medulla of the scolex but in the rest of the body the canals come to be arranged in groups in the lateral regions of the medulla. These canals converge posteriorly to enter a wide excretory duct opening at the posterior end of the body. Nervous tissue may be seen in transverse sections lying laterally between the inner longitudinal musculature and the region where the excretory canals are situated.

Testes are very numerous and are confined to the medulla. Their position in relation to the vitellaria is indicated in fig. 1. Sections show that in the anterior part of the testicular field, where uterine coils are absent, the vesicles are arranged in a single row. This field extends from the end of the first fifth of the body length to reach the most anteriorly-directed ovarian lobes. The testes are round or oval, measuring on average ·23 mm. in diameter. They form a continuous layer in the pre-uterine region but become displaced by the uterine coils so that they then lie mainly laterally with comparatively few vesicles scattered between the uterine folds. They diminish in number posteriorly and only a few are to be seen lying dorsally to the anterior ovarian lobes. Numerous efferent ducts may be seen between the uterine folds and these eventually join to form a wide vas deferens at about the end of the second third of the body length. It is at first dorsal to the uterus and may come to lie either on the right or left side of the midline. The duct then becomes narrowed and much coiled before widening again into a thick-walled tube whose wall contains muscle fibres. In one preparation a thin-walled vesicula seminalis was seen adjacent to the cirrus sac, but such a structure was not recognized in sections. After entering the cirrus sac the male duct is differentiated into a narrow ejaculatory duct lying coiled in the anterior

part of the sac. The cirrus, when retracted, occupies the posterior portion of the sac from whose ventro-posterior aspect it can communicate with the utero-vaginal canal which in turn opens by the genital pore into a shallow depression on the ventral surface of the worm. The cirrus is ·3–·38 mm. long by ·03 mm. wide. The sac is ellipsoid with its larger diameter in an antero-posterior direction, and with its posterior edge directed towards the ventral surface. Its shorter diameter is ·3–·46 mm.

The ovary is H shaped, with its isthmus and lobes lying entirely in the medulla. Its anterior lobes are larger than the posterior and may extend forwards as far as the level of the anterior margin of the cirrus sac. The isthmus is wide, the oviduct arising from it dorsally to one side of the midline. An oocapt was not observed.

The vitellaria are abundant and cortical, their distribution (on one side only) being indicated in fig. 1. Transverse sections through the middle of the uterine field show that the follicles are arranged in a single layer in the cortex outside the inner longitudinal musculature. Anteriorly to the uterus they are present only laterally. Near the posterior limit of their distribution they decrease in number and are also disposed only laterally. The most posterior follicles lie above and below the anterior ovarian lobes. Post-ovarian follicles are absent. The rounded or oval follicles measure about 90μ in diameter. Two ventral vitelline ducts formed by the union of several smaller ducts on each side join in the midline, and the common yolk duct so formed passes posteriorly, becoming swollen slightly into a yolk reservoir before joining the oviduct.

The uterus commences as a narrow tube at the junction of the oviduct and yolk duct (fig. 2), widening gradually and becoming thrown into many folds in the region behind the ovarian isthmus. The walls have also become considerably thickened, due to the presence of gland cells. This glandular uterus passes forwards above the ovary as an almost straight tube, but it becomes thrown into folds which may extend dorsally or dorso-laterally to the cirrus sac. Anterior to the latter the glandular ascending uterus may lie either dorsally or ventrally to the folds of the descending uterus. At about half the midlength of the worm the glandular portion of the uterus terminates and the uterus then becomes a wide thin-walled tube swollen with eggs and thrown into extensive folds lying on one side of the midline. After reaching the anterior limit of the uterine field (which lies at about the end of the first two fifths of the body length), the tube crosses to the other side of the median line to become again thrown into folds as it passes posteriorly. A short distance in front of the cirrus sac, the descending uterus approaches the midline and travels more or less dorsally to the sac and then curves sharply towards the ventral surface (fig. 1, 2). A short distance

before its termination it is joined by the vagina, the utero-vaginal canal thus formed opening at the genital pore adjacent to the posterior border of the cirrus sac (fig. 2). The vagina travels back dorsally to the ovary, where it enlarges to form a receptaculum seminis. It then narrows considerably to enter the lower part of the oviduct. The latter, after receiving the vagina, proceeds ventrally to meet the yolk duct, and in this region shell glands are present. Eggs measure 43 by 26μ.

Our species belongs to the Lytocestinae as defined by Hunter (1927; 1929; 1930), but differs from other members of the sub-family in many of its features. It is distinguished from *Lytocestus* (Cohn, 1908; Hunter, 1930; Woodland, 1926; Szidat, 1937) by the presence of a common genital pore, medullary ovarian lobes, and a long uterus extending into the pre-ovarian region of the worm. It differs from *Balanotaenia* (Johnston, 1924) in having an unspecialized scolex and in having uterine coils extending forwards beyond the cirrus sac. This latter feature distinguishes the new species from *Monobothrioides* (Fuhrmann and Baer, 1925) which also has a short uterus, a terminal introvert and separate genital pores. *Djombangia* (Bovien, 1926; Hunter, 1930) has a scolex with a terminal sucker and its eggs have spines. *Lytocestoides* (Baylis, 1928; Hunter, 1930) has a conical scolex, postovarian vitellaria and a relatively short uterus. We therefore erect a new genus *Notolytocestus* (southern *Lytocestus*) for its reception. The following diagnosis is suggested:

Lytocestinae; with scolex unspecialized and narrower than rest of body; cirrus opening into utero-vaginal canal as in *Caryophyllacides* (Nybelin, 1922); vitellaria entirely cortical; ovary and its lobes medullary; uterus extending nearly to the anterior margin of the testicular field; postovarian yolk follicles absent. Type *N. major* n. sp. from the Australian freshwater Siluroid, *Tandanus tandanus*.

NOTOLYTOCESTUS MINOR n. sp.

Fig. 6–7.

A single specimen of this small Caryophyllaeid was found in the intestine of a *Tandanus tandanus* caught by Miss L. M. Angel in December, 1947, near Murray Bridge. In company with it were many *Balanotaenia bancrofti*, some *Notolytocestus major*, and a *Biacetabulum*. The worm is 6·5 mm. long by 1·7 mm. broad (fig. 6).

Because of the characters of the anterior end and the distribution of the testes and vitellaria, the worm was at first thought to be a very young specimen of *N. major* but the specimen is egg-bearing, and amongst our material of *N. major* was one which was quite devoid of eggs but which was of about the

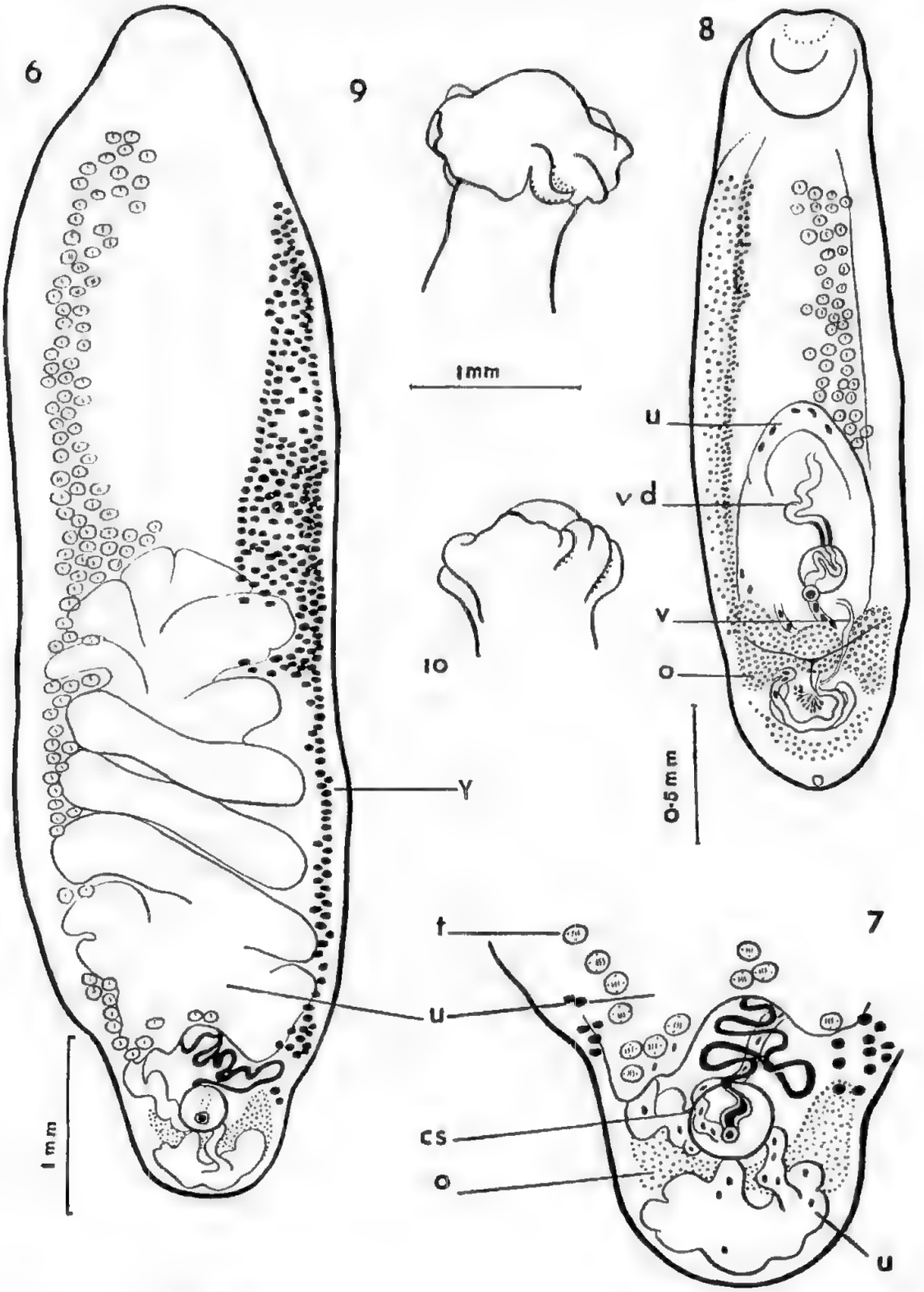

Fig. 6, 7. *Notolytocestus minor*. 6, Ventral view showing uterine field, and on one side, the distribution of the testes, on the other the vitellaria; 7, reproductive system; 8, *Biacetabulum tandani*; 9, 10, *Balanotaenia bancrofti*, ventral and dorsal views of scolex. (Figures 7 and 8 are drawn to the same scale.) Lettering as in preceding figures.

same size (11·5 mm. by 5·5 mm.) as the ovigerous worms. We think that the form now under consideration belongs to a different, but closely related, species. The eggs, testes, vitellaria and cirrus sac are all smaller than those of *N. major*.

The scolex which is not differentiated, is rounded anteriorly and narrower than the rest of the body; it widens gradually into the body. The posterior end of our specimen is contracted.

The testes are about 76μ in diameter and their field extends forwards to about one ninth of the body length from the anterior end. Their posterior limit could not be determined accurately because of the closely packed condition of the uterine folds. The vas deferens is much coiled and on one side extends laterally nearly to the margin of the body. It enters the cirrus sac on the antero-dorsal surface of the latter. On the midventral surface of the sac there is an aperture which may be either the male aperture or a common genital pore. The cirrus sac is spherical, ·23 mm. in diameter.

The vitellaria, as far as could be ascertained without studying sections, are cortical. Anteriorly they are arranged laterally but as the front limit of the uterine field is approached, they extend more toward the mid-ventral and mid-dorsal surfaces (fig. 7). They reach back as far as the wings of the ovary, and are absent from the post-ovarian region. They are rounded or oval, with an average diameter of 38μ.

Owing to the unusually great development of the uterus posteriorly, only the anterior part of the ovarian wings could be seen (fig. 7). Details regarding the post-ovarian part of uterus were not ascertainable. The uterus passes above the ovarian isthmus and cirrus sac and then becomes thrown into a mass of closely arranged folds which extend forwards to a point in front of the midlength of the worm. Only a small part of the descending uterus was recognized as such and this was seen dorsal to the cirrus sac. The uterus was densely packed with eggs averaging 39 by 20μ. The uterine pore and vagina were not recognized in the specimen.

The parasite seems to belong to *Nototylocestus* because of its anatomy (as far as is known), but we are uncertain whether the vitellaria are entirely or partly cortical.

BIACETABULUM TANDANI n. sp.

Fig. 8.

This minute mature cestode measures 2·1 mm. in length by 0·5 mm. in width. The body has rounded extremities, the scolex bearing two acetabula, one on the dorsal and one on the ventral surface. There is no neck, the scolex merging into the body without any marked alteration in breadth (fig. 8). There is a

terminal excretory pore. Six large excretory canals could be counted in the region in front of the uterus. One of these, on each side, could be traced as far back as the region of the ovary.

The oval testes measure 24–34μ in their shorter diameter and extend forwards to a region about one fifth of the body length from the anterior end. Posteriorly they reach almost the level of the cirrus sac where they can be detected only laterally because the uterus occupies most of the body in this region. The vas deferens is wide, and just before entering the rounded cirrus sac (114μ in diameter) on its antero-dorsal border, it passes into a thick-walled external vesicula seminalis. On leaving the latter the vas narrows to enter the cirrus sac. The cirrus opens into the utero-vaginal canal which terminates at the genital pore lying ventrally to the posterior edge of the cirrus sac. The genital aperture lies at a point three fourths of the body length from the anterior end.

The ovary is H shaped, the anterior points of the two wings almost reaching the level of the cirrus sac. The isthmus in dorso-ventral view is circular, forming an ovarian reservoir as described by Hunter (1927) for *Biacetabulum infrequens* and *Caryophyllaeus terebrans* Linton.

The uterus extends forwards almost to the midlength of the body and, in the single specimen studied, is packed with eggs except in the post-ovarian portion of the duct. The latter region of the uterus, the beginning of which is surrounded by shell glands, is thrown into a number of loops. It passes forwards until it lies about 0·5 mm. in front of the cirrus sac. The descending limb travels back to reach the level of the ovary before turning forwards to terminate at the genital pore. The vagina travels forwards on one side of the oviduct and then bends towards the midline to meet the uterus. At about the level of the anterior border of the ovarian isthmus an elongate receptaculum seminis is formed. The average size of eggs is 48 by 28μ.

The vitellaria appear to be medullary in position. They are distributed laterally and extend forwards almost as far as the testes, and posteriorly as far as the ovary. There is a group of post-ovarian yolk glands. The follicles measure 6–8μ in diameter. Two yolk ducts join to form a median vitelline duct, but the duct from the post-ovarian group was not observed.

The anatomy, as far as the study of a single specimen has permitted, indicates that the worm belongs to the Caryophyllaeinae because of the position of the sex apertures in the last quarter of the body length and the probable medullary position of the vitellaria. The presence of uterine glands was not established. Our species exhibits many of the characters of *Biacetabulum*. Although it does not possess a well defined scolex, two sucker-like depressions were observed. It resembles *Biacetabulum* in the relationship of the sex aper-

tures, the shape of the ovary, the anterior extent of the uterine field, as well as the presence of an external seminal vesicle and post-ovarian vitellaria. It differs from all previously described species of that genus in its smaller size, absence of neck region and well-marked loculi, and in the smaller size of the testes, vitellaria and cirrus sac. *B. tandani* is the first member of the Caryophyllaeinae to be recorded from Australia.

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